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ABSTRACT

In December 1997, three of Missouri's key educational boards--the State Board of Education, the Coordinating Board for Higher Education, and the University of Missouri Board of Curators--created an historic partnership among business, education, and political leaders. Known as the Missouri K-16 Coalition and composed of prominent Missourians committed to quality education at all levels, the partnership signifies an exceptional and necessary mode of cooperation among Missouri's education policymakers. Since its formation, the Coalition has focused its discussions on ways to produce a more coordinated system of education and to raise the performance levels of all Missouri students. The Coalition reviewed a number of research documents and technical reports which provided a comprehensive background regarding a range of issues, including the importance of mathematics, the performance of U.S. and Missouri students, and the relationship of mathematics performance to individual productivity and economic viability. This report reflects a sense of urgency about the tasks ahead as well as a sincere appreciation for what Missouri's high schools and colleges have already accomplished to improve achievement levels. The conclusions and specific recommendations contained in this report reflect what the Coalition believes to be necessary to reach critical objectives for Missouri. What students need to learn and how to equip novice and veteran teachers at all levels to facilitate new standards are major concerns. More direct collaboration within and between K-12 and higher education is identified as a key strategy. This report also addresses the need for a comprehensive and sustained public information effort to support the systemic change. Appendix 1 lists the official charge to the Coalition by the three boards and the list of Coalition members. Appendix 2 contains a list of resources considered by the Coalition over the past 21 months. Appendix 3 provides a list of supplemental resources. (Contains 45 references.) (ASK)

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ED 441 689

REPORT OF THE MISSOURI K-16 COALITION TO

MISSOURI COORDINATING BOARD FOR HIGHER EDUCATION
MISSOURI STATE BOARD OF EDUCATION
UNIVERSITY OF MISSOURI BOARD OF CURATORS

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Preamble

In December 1997, three of Missouri's key educational boards, the State Board of Education, the Coordinating Board for Higher Education, and the University of Missouri Board of Curators, created a historic partnership among business, education, and political leaders. Known as the Missouri K-16 Coalition and composed of prominent Missourians committed to quality education at all levels, the partnership signifies an exceptional and necessary mode of cooperation among Missouri's education policymakers. Since its formation, the Coalition has focused its discussions on ways to bring about a more coordinated system of education and raise the performance levels of all Missouri students.

Missouri's K-16 initiative, along with similar K-16 initiatives in several other states, has emerged as an effort to raise performance standards for all students and to improve the alignment of curriculum between K-12 and higher education. K-16 work acknowledges the reality that students proceed at different paces through the educational system and have different career or life objectives. K-16 efforts have emphasized the need for high school and college collaboration, encouraging improved connectivity and alignment between the two levels, which will allow students to advance through the system in a more integrated and efficient way.

Focusing initially on grades 11 and 12 and the first two years of higher education, the Coalition has concentrated on ways to increase Missouri students' success in mathematics. The Coalition was charged by its sponsoring boards with:

- *promoting quality performance standards that reduce the need for remediation,*
- *encouraging faculty agreements on content and expectations in the major disciplines, beginning with mathematics,*
- *increasing public awareness of the importance of improved student performance,*
- *supporting full articulation within and across educational sectors,*
- *identifying strategies for enhanced student performance based upon preparation and ability, and*
- *developing policy recommendations to be shared with the Coordinating Board for Higher Education, the State Board of Education, and the UM Board of Curators.*

The Coalition reviewed a number of research documents and technical reports. This information provided a comprehensive background regarding a range of issues, including the importance of mathematics, the performance of U.S. and Missouri students, and the relationship of mathematics performance to individual productivity and economic viability.

This report reflects a sense of urgency about the tasks yet ahead as well as a sincere appreciation for what Missouri's high schools and colleges have already accomplished to improve achievement levels. The issues identified are not aligned with those of a particular group of stakeholders; they are public issues that cut across the educational system. The problems are systemic and relate to diverse elements, e.g., parental attitudes toward the importance of rigorous mathematics curricula, the preparation of K-16 faculty as colleagues who effectively participate in teaching and learning, the funding of school districts, and the selection of textbooks.

The Coalition was assisted and supported in its work by several staff members from the Department of Elementary and Secondary Education, the Department of Higher Education, and the University of Missouri system. In addition, the Coalition established a Mathematics Technical Advisory Committee (MTAC). The chair of the Missouri K-16 Coalition (a mathematician) also chaired MTAC. MTAC included faculty representatives from several of Missouri's two- and four-year colleges and universities as well as teachers from the K-12 mathematics community. Throughout its deliberations, MTAC had significant contact with standing professional groups in mathematics, e.g., the Mathematics Association of America, the Missouri Mathematics Association for Two-year Colleges, and the National Council of Teachers of Mathematics.

The conclusions and specific recommendations contained in this report reflect what the Coalition believes to be necessary to reach critical objectives for Missouri. What students need to learn and how to equip novice and veteran teachers at all levels to facilitate new standards are major concerns. More direct collaboration within and between K-12 and higher education is identified as a key strategy. Finally, the report addresses the need for a comprehensive and sustained public information effort to support the systemic change. Listed in Appendix I are the official charge to the Coalition by the three boards and the list of Coalition members. Appendix II contains a list of resources considered by the Coalition over the past 21 months, while Appendix III provides a list of supplemental resources.

In its recommendations, the Coalition identifies important actions for all Missouri's citizens that will result in increasing student expectations and improving achievement in mathematics. The vision includes all students reaching their potential through cooperation, reinforcement, dedication, and hard work.

Introduction

Many people have a limited understanding of the fundamental nature of mathematics. Mathematics is not simply the calculation of numbers or the manipulation of abstract symbols. Mathematical thinking is key to being able to analyze and solve problems of all kinds. When the essentials of many problems are abstracted into a mathematical framework, solutions become more apparent. Mathematics helps students develop critical-thinking skills. Indeed, it is the essence of mathematics to think logically, to be able to draw sound conclusions, and to understand relationships and causalities.

Those who have strong backgrounds in mathematics are able to think more clearly and critically about all aspects of life and develop skills that are useful in almost all occupations. Mathematics is especially crucial for participation in technologically advancing societies. Reflective of this reality, the Missouri Assessment Program (MAP), the statewide testing program in Missouri schools under the authority of the State Board of Education (SBE), began its assessment of Missouri's high school students by examining their mathematics skills. In so doing, the SBE has underscored the importance of monitoring the mathematics performance of Missouri students.

Missouri's work in raising expectations for all students and accelerating improvement in mathematics education is centrally important to the state's economic future. Because the nature of the workforce is continuously changing and becoming more technologically sophisticated, mathematics has a direct impact on Missouri's economic future and the well-being of its people. Instead of standing at assembly lines, workers now rely on technical competence to manage complex machinery and to solve complex technical problems. Mathematics is important to Missouri's economic future because business and industry look for an educated workforce when deciding upon communities in which to locate. An increased reliance on advanced technology in the workplace suggests that individuals without sound competence in mathematics will be denied economic opportunities and that the state's economic security will be inherently linked to the mathematical skills of Missouri's citizenry.

Because mathematics is a cumulative discipline involving all levels of formal education, it is a compelling focus of K-16 work. The basics of mathematics must be learned well because it forms the foundation for more advanced study. That is why it is essential that curricula in the early grades adequately prepare students for later work in mathematics, why it is important to correct students' deficiencies in mathematics before it is too late, why it is important that students and parents make wise choices about the kinds of mathematics courses to be taken, and why it is important that the college-level curriculum be sensitive to the experiences that students bring with them. In fact, there is good evidence that adequate preparation in mathematics is the single best predictor of college completion.

For all these reasons, the Coalition believes it is vital that Missourians share a sense of urgency about accelerating progress in mathematics and raising mathematics standards even higher, not just at the K-12 level, but at the college level as well. At the same time, there are many other areas in which work across grades K-16 is essential. Missouri's education boards should continue to establish structures that will improve academic performance in areas other than mathematics, e.g., reading, writing, science, and history. The Coalition believes that many of the principles and policy recommendations growing out of its work in mathematics will apply to these other fields as well.

Student Learning

The need to accelerate the rate of improvement

During the 1995-96 academic year, the Department of Elementary and Secondary Education (DESE) established high standards for mathematics achievement of Missouri students. Such high standards in mathematics are critical because of the increasingly vital role that mathematics plays in effective decision-making and economic success. While Missouri has begun foundational work to improve student performance in mathematics, as a state, Missouri still has much to do to meet these high standards. Every Missourian has a role to play in this effort.

The achievement level of Missouri students in mathematics is not acceptable for today's technological society.

Because Missouri's statewide standards in mathematics are less than five years old, the curricular changes needed to reach those standards are just now being put in place in most districts across the state. Nevertheless, there is evidence that the achievement level of Missouri students has improved in the last five years. Missouri is on the right track – but there is a need to accelerate the progress. Since other nations are strengthening their standards and improving the achievement of their students, we are aiming at a moving target. Competition for economic strength does not come from institutions within the state or between neighboring school districts; instead, it comes from nations around the world that are taking technical education seriously and recognizing the increasing need for mathematics in a technological world. As Will Rogers once said, "Even if you're on the right track, you'll get run over if you just sit there."

Missouri's public colleges and universities produce fewer than the national average number of mathematics degrees (as a percentage of total degrees). This fact, coupled with the high number of students taking remedial courses in mathematics in colleges and universities, means that higher education also has an important role in addressing this problem.

As the Missouri K-16 Coalition stated in September 1998, "Evidence from multiple sources demonstrates that the achievement level of Missouri students in mathematics is not acceptable for today's technological society." There is clear evidence that at all educational levels, Missouri students are not achieving at sufficient levels in mathematics to ensure either their own future success or the state's economic well-being. For instance:

- Results on the worldwide Third International Mathematics and Science Survey put Missouri 8th graders' performance at the national average in science and mathematics; yet the U.S. national average is significantly below those of other leading nations in the world.

- On the recent statewide 10th grade test in mathematics, only 10 percent of Missouri students scored at a level considered "proficient" by state standards.

- Missouri colleges and universities have only minimal expectations for mathematics proficiency for students graduating with associate and baccalaureate degrees.
- Missouri colleges and universities award a lower percentage of degrees in mathematics-related technical fields than the national average.
- The average ACT subscale in mathematics for students entering Missouri colleges and universities is 21.0. Although this composite score is slightly above the national average, it is the lowest of the subject areas tested.
- In 1996, 26 percent (4,628) of high school graduates enrolled in Missouri's public colleges and universities were enrolled in remedial courses, and of that number, 71.4 percent (3,304) were enrolled in remedial mathematics courses.
- Missouri business leaders testify to the lack of sufficient personnel with adequate technical training to fill the needs of a high-tech economy.

The ability to reduce barriers depends on having better information about where problems occur in the K-12-to-college transition.

Successful transitions from K-12 through college

Creating a seamless system of education means reducing barriers. The Coalition believes that the ability to reduce barriers depends on having better information about where problems occur in the K-12-to-college transition. Thus, the Coalition began its work by assessing the academic performance and progress of students through the educational system, with particular emphasis on grades 11 and 12 and the first two years of college. While Missouri has a student-specific database that is useful to monitor the transition from Missouri high schools to the state's public colleges and universities, this database includes neither course-level data nor a full range of assessment. These data elements are necessary for an extensive examination of relationships between course-taking patterns, placement data, and student performance. As a consequence, a special study was commissioned to determine the success of students in collegiate mathematics courses as a function of their high school preparation, MAP mathematics test scores, and scores on admissions tests. The results of that study are still being analyzed. Continued commitment is needed to ensure that data across K-16 is available for analysis.

Recommendation: The Coalition recommends that the three sponsoring boards work cooperatively to improve available information about Missouri education by:

- *using common data definitions,*
- *linking their separate databases, and*
- *developing a common research agenda that can inform future K-16 policy decisions.*

The Coalition also suggests that each board appoint a liaison staff person to work jointly on this recommendation, and it requested a brief progress report. Representatives from each board indicate that initial discussions have taken place regarding how best to institutionalize a reporting system that would permit an ongoing analysis to inform K-16 discussions. The proposed system would build on existing data-collection processes by appending selected state and national assessment results and placement data to allow for ongoing analyses of students' performance and progress. A remaining challenge to this effort is the need for course-specific information and information on students' academic performance in mathematics courses taken both in high school and college. Another challenge involves the limitation of the existing data systems, which only include the state's public institutions. Staff from the three boards will continue to collaborate on developing a data-collection system that is responsive to the Coalition's recommendations.

The faculty perspective is essential, especially in the development of state-level policy related to curriculum issues.

Throughout its work, the Coalition has acknowledged the invaluable contributions of the Mathematics Technical Advisory Committee (MTAC). It is through MTAC that the voice of faculty has been heard. The faculty perspective is essential, especially in the development of state-level policy related to curriculum issues. Without faculty involvement and support, policies involving teaching and learning will have limited impact. Therefore, the Coalition supports the establishment of an ongoing advisory committee of mathematicians.

Recommendation: *The Coalition recommends that the three sponsoring boards establish a standing mathematics technical advisory committee. Such a committee should include representatives of the relevant professional societies in Missouri, both two-year and four-year colleges and universities, and mathematics teachers and administrators from K-12 education. This group should be charged with maintaining cross-sector discussions about mathematics and advising the relevant boards about issues in mathematics. In particular, such a group should comprehensively review the mathematics curriculum and associated assessments in the four years from the third year of high school through the first two years of college.*

Raising expectations for all

Parents, students, school boards, business leaders, political leaders, and educational leaders must understand that the ability to function in a mathematically sophisticated and technologically rich environment is crucial. While many people clearly recognize the importance of mathematics, a low regard for mathematics is still common. For example, one Missouri college administrator reports that the most common question she hears from parents is, "Why does my child have to take mathematics at your college when everyone has a calculator?" This understanding of mathematics as calculation, unaccompanied by the realization that mathematics is the key to modeling the world, analyzing

natural and social phenomena, and solving problems in all sorts of fields, is a severe barrier to achievement. It works against achievement for students to be surrounded by a climate of fear and lack of understanding about the power, importance, and beauty of mathematics. MTAC's recommendation that more algebraic thinking be incorporated earlier in a student's educational experience is responsive to these attitudes and is reflected in recommendations for proposed legislation and professional development activities.

Appropriate diagnostic information should be available to schools so that deficiencies in curriculum or in teacher preparation can be corrected.

The Coalition believes that it is critical that all students have adequate mathematical skills; that all teachers at the elementary level be comfortable with, and be able to convey, essential mathematical concepts and be able to stimulate mathematical interest; and that mathematics achievement is essential preparation for all postsecondary choices, whether in the workforce or in further educational experience. It is also important for all business and industry leaders and all involved in education-related decision-making to help raise awareness of the need for higher mathematics achievement by Missouri students. It is important for all parents to understand that the world has changed, that failing to demand and take challenging mathematics courses closes doors to many options, and that any anxieties they may have about mathematics must not stand in the way of the acquisition of mathematical competence by their children. In meeting these challenges, the Coalition acknowledges the significance of a major information campaign on the importance of mathematics.

Failing to demand and take challenging mathematics courses closes doors to many options.

Recommendation: *The Coalition recommends a comprehensive and sustained public information campaign to raise the awareness of the general public, business leaders, educators, and political leaders about issues surrounding mathematics education.*

The existing MAP testing program, developed and administered by the State Board of Education, represents an important beginning for raising the achievement levels of Missouri students. Future editions of this test should focus even more on mathematical concepts and understanding. Moreover, expectations for mathematical skills should be gradually raised. Though testing will not, in and of itself, produce higher achievement any more than more frequent weighings of a pig will ensure that it gains more weight, appropriate diagnostic information should be available to schools so that deficiencies in curriculum or in teacher preparation can be corrected.

Expectations for mathematical skills should be gradually raised.

Recommendation: *The Coalition recommends that K-12 schools and higher education institutions use the summary diagnostic information concerning test results supplied by the Department of Elementary and Secondary Education to identify curricular and other issues in need of attention. This diagnostic information, together with other information available to the schools, should be used to help individual students in determining any areas of weakness in mathematics and in providing remediation to help them overcome those deficiencies. Because of the cumulative nature of mathematics, it is also important for parents to*

know where their children's deficiencies are so they can ensure that their children receive appropriate help.

The Coalition applauds the Missouri General Assembly and Governor Mel Carnahan for the provision of House Bill 889 (1999), which now provides incentives to school districts to offer instruction outside the traditional school day to students who fail to meet established local academic standards.

Recommendation: *The Coalition recommends that the State Board of Education, leaders in the Missouri General Assembly, and the governor's office continue to seek ways in which the results of increasingly demanding tests in mathematics can be translated more directly into school improvement and the provision of individual remediation.*

Integrating algebraic thinking into elementary, middle, and junior high school classes...could have a significant impact on mathematics achievement.

While Missouri's governor and legislature have led the way in stressing the importance of high standards and in developing accountability mechanisms by which to measure progress, there is still more that can and should be done. Building on MTAC's recommendation to move algebraic thinking into the early grades, the Coalition supports initiating legislation that will encourage local districts to achieve this goal.

Recommendation: *The Coalition recommends that the Missouri General Assembly adopt legislation explicitly identifying the state's interest in raising mathematics achievement levels. Such legislation should establish a grant program through the State Board of Education to help integrate algebraic thinking into elementary, middle, and junior high school classes. The Coalition believes this could have a significant impact on mathematics achievement at all levels in the state of Missouri in years to come.*

The Coalition also is concerned about expectations for mathematics in higher education. A survey of Missouri colleges and universities about the assessment of students' mathematics performance in general education is underway. Other concerns include the relatively low numbers of majors in technical fields being produced by Missouri colleges and universities and about the critical need in Missouri for K-12 teachers of mathematics.

Recommendation: *The Coalition recommends that the Coordinating Board for Higher Education and the University of Missouri Board of Curators work with the standing mathematics technical advisory committee of faculty in taking steps to raise the expected levels of mathematics achievement for all college students. These steps may include using the CBHE's budgetary Funding for Results program to provide financial incentives for improved mathematics performance. More powerful financial incentives, perhaps in the form of student scholarships or approaches like the Advantage Missouri Program, should be considered by the CBHE through its budgetary processes.*

In all such steps that they might consider, the Coalition recommends that the CBHE work closely with college and university

presidents to ensure that incentives do not simultaneously produce unintended negative consequences.

Teacher Preparation and Support

The Missouri K-16 Coalition has deliberated about how to promote exemplary initial preparation for new teachers as well as how to help good Missouri teachers become even more effective facilitators of student learning. Ample research confirms that teacher quality is a major determinant of student achievement. While there is a myriad of factors related to student achievement, such as family socioeconomic status, parental involvement in setting expectations, funding of schools, class size, and textbook quality, almost none of these directly influences student performance as much as the quality of teaching.

A key component in the overall development of effective educators is the groundwork laid by Missouri higher education institutions in preparing elementary and secondary teachers. The preparation of teachers is often not seen as the responsibility of an entire institution but, instead, solely as the duty of the school, college, or department of education. While pedagogical training and extensive field experiences in real classrooms are vital to teacher preparation, basic content is equally important. Core subjects are taught in arts and sciences departments. Such departments and their administrators, however, do not always feel as connected with the important task of preparing teachers as they should. Preparation of teachers should be well grounded in disciplinary content knowledge as well as in sound pedagogical principles. Colleges and universities need to take seriously their commitment to the initial preparation of, and continuing professional development for, teachers. That commitment needs to be shared by colleges of arts and sciences (for disciplinary content) and colleges of education. DESE's Missouri Standards for Teacher Education Programs (MoSTEP) reinforce the importance of this integration.

Preparation of teachers should be well grounded in disciplinary content knowledge as well as in sound pedagogical principles.

The Coalition commends the State Board of Education for the preparation of the *Missouri Teacher Preparation Institution Profiles*, the nation's first "consumer's guide" to teacher preparation programs. This guide pulls together a number of indicators about teacher preparation programs, including such things as test scores of graduates on the National Teachers Exam, an examination required for prospective teachers in each discipline area.

MTAC is working with Department of Elementary and Secondary Education to examine possible improvements in the certification standards for Missouri teachers. The Coalition applauds the State Board of Education for insisting that the performance of prospective teachers in Missouri must be at or above the national

The performance of prospective teachers in Missouri must be at or above the national average.

average on the Praxis II Examination. The devices used to measure teacher performance, however, must be rich enough to provide sound assurance of teacher quality. In particular, some currently used tests of content knowledge may not provide a sufficient examination of mathematics ability to ensure that elementary teachers are able to get students adequately started in mathematics. Test results can be problematic if future elementary school teachers are able to meet minimum standards without demonstration of sufficient content knowledge in mathematics. A new examination now under development by the Educational Testing Service (ETS), as well as changes in Missouri's passing standards, may help this situation.

Recommendations:

- *The CBHE should find new ways for all Missouri colleges and universities that prepare teachers to engage their entire institutions in teacher preparation. In particular, the CBHE should provide incentives and encouragement for the active participation of arts and sciences departments in the design and implementation of teacher preparation programs.*

- *The CBHE should encourage the presidents and chancellors of Missouri colleges and universities that prepare teachers to give appropriately high priority to teacher education as an important part of their institutional missions.*

- *Along with arts and sciences and education faculty from colleges and universities, master K-12 mathematics teachers should be involved in the initial preparation of new teachers and professional development of current teachers.*

The CBHE should encourage the partnership between arts and sciences faculty and colleges of education faculty.

- *The CBHE should find ways to "encourage" colleges and universities to take the partnership between arts and sciences faculty and colleges of education faculty seriously, in accord with the Excellence in Education Act.*

- *The Coalition encourages the CBHE to ensure that presidents and chancellors of colleges and universities are aware of the* Missouri Teacher Preparation Institution Profiles *and become personally involved in correcting any deficiencies in the institutional programs that this guide may suggest.*

- *There is an important role for the CBHE in the review of existing teacher education programs in postsecondary institutions. The Coalition recommends that the State Board of Education and the Coordinating Board for Higher Education pursue this possibility.*

- *Because it is vital to have teachers at the elementary and secondary levels who are both competent in, and comfortable with, mathematics, the Coalition encourages DESE and the standing mathematics technical advisory committee of faculty to continue working comprehensively on the assessment of prospective teachers.*

Professional Development

As with testing of students, the testing of new teachers alone is not enough; we must also help veteran teachers. Available evidence indicates that at least half of the teachers currently teaching mathematics in Missouri elementary and secondary public schools have never had any continuing education in mathematics. In light of the new standards in mathematics and subsequent changes in textbooks and other curricular materials, continuing education (usually called "professional development") is vital. It is not realistic to expect teachers who underwent initial preparation several years ago—and who were perhaps not always well prepared in mathematics—to be able to help students effectively learn new material.

Much evidence from international test results indicates that one of the major problems with mathematics in America is that algebraic thinking is introduced too late in the curriculum.

MTAC conducted regional hearings at the nine Regional Professional Development Centers around the state, to which both high school and collegiate mathematics faculty were invited. Through MTAC, discussions have begun around the state about competencies needed in mathematics at various grade levels and how we can make what is expected at the end of one educational experience match what is assumed at the beginning of the next educational experience.

As referenced earlier in this report, MTAC believes that it is important to focus efforts on strengthening middle school (grades 5-8) mathematics by helping teachers move from an understanding of mathematics as calculation to incorporating higher-order mathematical reasoning that will introduce algebraic thinking. Much evidence from international test results indicates that one of the major problems with mathematics in America is that algebraic thinking is introduced too late in the curriculum to enable students to progress in mathematics as rapidly as students in many other countries. MTAC believes that professional development for teachers, together with suggestions about textbooks and other curricular materials that are more appropriate for middle school mathematics, can significantly improve the mathematical preparation of students in grades 5-8.

The Coalition applauds DESE for its allocation of approximately $500,000 in SB380 funds for mathematics. The Coalition is pleased to note that a new three-year program of professional development in mathematics, designed to be instituted in the schools and supported by a major grant of SB380 funds, has been developed by DESE. The program is designed to begin with intensive training sessions at each of the RPDCs around the state, beginning with 44 school and district teams. Each team will be responsible for developing a three-year program of mathematics professional development that will be tied to school improvement plans and focus on student achievement as the desired outcome.

In a parallel move, the CBHE recently redirected a higher proportion of federal funds for professional development in the area of mathematics. The portion of the Eisenhower Professional Development Program administered by the CBHE provides money for the improvement of K-12 mathematics and science teaching. In addition, continuous improvement of teaching and learning is a major focus of the CBHE's Funding for Results program.

Effective professional development must not be an isolated activity; it must relate to, and be supportive of, overall improvement efforts that are underway within educational environments.

Though relevant to effective education generally, it appears that much professional development activity is directed to areas of school concern that are not directly related to disciplinary content. In addition, effective professional development must not be an isolated activity; it must relate to, and be supportive of, overall improvement efforts that are underway within educational environments. School boards, in particular, can play a vital role in professional development. They can help administrators and teachers understand the need for strong mathematical teaching and learning. Furthermore, they can hold administrators accountable for providing effective professional development opportunities and teachers accountable for participating in them. As elected community leaders, they play a pivotal role in helping parents understand the key role that challenging mathematics plays as part of their district's K-12 programs.

Recommendations:

- *Middle school mathematics teachers should be provided with ongoing professional development that will help them move from teaching mathematics as "calculation" to incorporating more higher-order mathematical reasoning and algebraic thinking into the classroom.*

The need for disciplinary content in professional development should be stressed.

- *The Coalition suggests that the Department of Elementary and Secondary Education reexamine its publication* Missouri Professional Development Guidelines for Student Success. *These suggestions to school professional development committees should appropriately stress the need for disciplinary content in professional development.*

- *The Coalition recommends that SBE and CBHE look carefully at how much of their respective professional development expenditures are being spent to enhance content knowledge in basic subjects and, equally important, what accountability there is for the results from these expenditures.*

- *The progress and outcomes of the new three-year program of professional development in mathematics developed by DESE and supported by SB380 funds should be carefully followed. Assuming good results, this approach should become a permanent feature in Missouri's professional development program.*

- *Exemplary professional development programs for content, pedagogy, and/or technology improvement should be identified by the*

SBE and the CBHE and recognized publicly.

- *Professional development should be seen by local school boards as a collaborative activity between administrators and teachers, well integrated into the structure of the school, high on the agenda of both the leadership of the school and the teachers, and closely related to school improvement and student achievement.*

- *Local school boards should target their available professional development dollars for critical needs of the district. The Coalition believes that, in most cases, these include mathematics.*

- *In order to encourage more collaboration between K-12 and higher education faculty, the Coalition recommends to the SBE, the CBHE, the University of Missouri Board of Curators and other institutions involved in teacher education that community college faculty and faculty from four-year institutions' colleges of education and colleges of arts and sciences be encouraged to participate in professional development activities provided for K-12 faculty, where appropriate. In addition, colleges and universities professional development activities should include participation by K-12 faculty.*

Regional Professional Development Centers (RPDCs)

Professional development funds require careful stewardship and effective accountability.

Professional development of K-12 educators involves many stakeholders and significant federal, state, and local resources. Additional funds are dedicated to the professional development of higher education faculty. These significant resources require careful stewardship and effective accountability as identified in DESE's MoSTEP. Missouri has an elaborate system of professional development, established by state law, some of which operates through nine Regional Professional Development Centers (RPDCs) which are located on the campuses of the University of Missouri, Truman State University, Northwest Missouri State University, Central Missouri State University, Southeast Missouri State University, and Southwest Missouri State University.

In local districts, professional development is largely determined by each school's professional development committee, as mandated by Missouri law. These committees set up professional development programs for their schools and arrange for professional development experiences to meet their goals. Some of these experiences occur through RPDCs. The professional development plans are to relate to, and support, the local school's total School Improvement Plan—a very desirable linkage. The Department of Elementary and Secondary Education provides guidelines for professional development, but it does not control the choices made by local schools.

Each RPDC is challenged to promote collaboration among existing programs, service providers, and local schools; to pro-

vide focus on key factors that will demonstrably improve student learning; and to share information on the impact of particular strategies and initiatives. The RPDCs, although only accounting for perhaps 20 percent of professional development in Missouri, represent convenient vehicles for helping achieve Missouri's goals for professional development.

The Missouri K-16 Coalition is eager to strengthen the RPDCs' role in mathematics professional development and to enable them to help districts improve student performance more effectively. Training and continued professional development throughout Missouri's entire educational system should be a priority, and the Coalition supports the further strengthening of the nine Regional Professional Development Centers as a part of that priority. Local school districts should also give high priority to professional development. To advance progress toward these goals, the Coalition adopted the following specific recommendations related to RPDCs. Although the Coalition's initial focus is on mathematics, these recommendations are independent of discipline.

Training and continued professional development throughout Missouri's entire educational system should be a priority.

Recommendations:

- *Each RPDC should be structured so that it operates as a long-term and integral part of the host institution, working closely with all units and faculty throughout the campus, but especially with arts and sciences and education faculty. In particular, appointment of the director and selection procedures for membership on the advisory committee of each RPDC should be mutually agreed to by the SBE and the president/chancellor of each host institution.*

- *Each RPDC director should have access to, and the support of, the senior administrative team of the host institution. In addition, the RPDC should be accountable to the host institution and to the SBE.*

RPDC activities must include strong disciplinary content and must focus on improved performance.

- *RPDC activities must include strong disciplinary content and must focus on the improved performance of students. Faculty from across K-16 must participate both as deliverers and receivers of services.*

- *The CBHE and SBE should work with presidents and chancellors of colleges and universities to ensure that they understand the role of the RPDC and that they will see that each RPDC has available content expertise, particularly in mathematics, to support its important work in professional development.*

- *Each RPDC should have a clear vision and clearly defined performance goals that can be evaluated by measurable outcomes, including success in leveraging resources and focusing existing programs on both state and regional priorities; effectiveness in promoting collaboration among arts and sciences departments, education, local schools, and other service providers; increased teacher satisfaction; and improved student performance.*

The ultimate success of the Missouri K-16 Coalition's recommendations for improving mathematics performance clearly depends on the quality and commitment of the state's teachers. Across all levels of the K-16 educational enterprise, faculty must be provided with both initial and ongoing opportunities to improve their knowledge of mathematics and to expand their skills in effective approaches to mathematics instruction.

Missouri cannot be competitive in a global economy without having a stronger base of men and women well-trained in technical, mathematics-related fields.

Conclusions: Summary and Implementation

Missouri cannot be competitive in a global economy without having a stronger base of men and women well-trained in technical, mathematics-related fields. Higher achievement in mathematics is essential for both the future economic well being of Missouri students as well as the economic well being of this state. The Missouri K-16 Coalition has reviewed data and developed recommendations that it believes will make a difference in the mathematics achievement of Missouri students in the years to come. These include raising expectations (with particular focus on middle school and higher education) both in mathematical training of students and particularly in the preparation of teachers; strengthening initial teacher education programs and making major improvements in professional development opportunities and in the use of those opportunities in school districts; utilizing school settings for professional development activities; providing incentives and legislation to bring about desired results; recruiting potential teachers, retaining and retraining existing teachers, and increasing public awareness of the importance of mathematics for students at all levels. Collectively, these recommendations focus on making the educational experience seamless from kindergarten through four years of college.

If everyone gets involved, we can truly make a difference.

There is something important for everybody to do. The Coalition believes that if everyone gets involved, we can truly make a difference. Advice to each stakeholder group follows.

Advice for Students and Parents

- At an early age students should understand that mathematics and mathematical thinking are crucial in creating lifetime opportunities for success in any discipline of their choosing. Success in this technoiogically sophisticated society requires individuals who have taken more advanced and challenging mathematics courses throughout their school years.

- Mathematics is an especially important discipline because it serves as the foundation for a student's future education and career options. Parents should encourage students to pursue a challenging math curriculum during middle school and high school so that they are well-prepared for the future —regardless of their career and educational goals.

- Parents must help set high expectations for their children and not let them be intimidated by mathematics. Parents should be careful not to "pass on" negative attitudes, experiences, or anxieties about mathematics to their children.

- Parents can help ensure that students succeed by encouraging children to take algebra before the ninth grade, if possible, and to continue to study mathematics throughout high school and college.

Advice for Business and Industry

- Business leaders and employers should work with school districts and institutions of higher education to raise expectations for student performance in mathematics.

- Business leaders in every sector should work with local educators, visit schools, and talk with students, parents, and teachers about the importance of mathematics and its specific applications in business and industry.

- Business leaders should communicate with school counselors, students, and their parents on a regular basis about the academic skill requirements necessary for entry-level positions in the workforce.

Advice for K-12 Schools

- The mathematics curriculum in K-12 schools should be structured to provide organized and systematic progression across levels. Elementary-level programs must include foundation for work at the middle level. Similarly, middle school programs need to incorporate the knowledge and skills, particularly algebraic thinking, that are necessary for high school classes. High school mathematics should prepare students for postsecondary education or career choices. Teachers and school officials must emphasize high frameworks for all students, creating a challenging curriculum that places an earlier emphasis on learning algebraic and geometric concepts and problem-solving applications.

- The Missouri Assessment Program must be aligned with the new curriculum expectations. In this way, school boards, school administrators, and faculty can use data from state assessments and other sources to analyze students' performance in mathematics and to focus resources on identified weaknesses at district, school, classroom, and individual levels.

- Local school boards and school personnel should focus professional development efforts for their faculty on strengthening their knowledge of mathematics, as well as effective mathematics instructional approaches at all levels, and preparing all students to meet the proficiency goals of the Missouri Assessment Program.

- School boards, school administrators, and faculty should use data from state assessments and other sources to analyze student performance in mathematics and accordingly focus their efforts for student improvement.

Advice for Colleges and Universities

- Colleges and universities should be sensitive to the role that faculty play in the preparation of teachers, thereby making the development of Missouri's future teaching workforce a total institutional responsibility.
- Presidents and chancellors of colleges and universities have a key role to play in emphasizing the importance of and redesigning support systems for teaching as a profession.
- Data provided by the CBHE and SBE should be used to evaluate systematically the effectiveness of teacher education programs.
- Presidents and chancellors of colleges and universities should become more actively involved with the SBE to ensure strong leadership in the appointment of RPDC directors and advisory committees.
- Colleges and universities should work closely with K-12 colleagues in the design and delivery of professional development programs targeting the improvement of teaching and learning at all levels.
- Colleges and universities should review their general education curricula and raise standards for mathematics performance levels expected of all students regardless of major.
- Colleges and universities should design strategies to attract more students to mathematics and mathematics-related disciplines.
- Colleges and universities should identify financial incentives that can be used to support improved mathematics performance.

Advice for Regional Professional Development Centers

- Each RPDC should become a central hub of activity in support of improved teaching and learning throughout all educational levels.
- Performance goals should drive systematic evaluation of the effectiveness of each RPDC.
- Knowledge of disciplinary content must be viewed as a necessary foundation for effective teaching, and should be primary when designing professional development programs.

Advice for Legislators and the Governor

- The State Board of Education, leaders in the Missouri General Assembly, and the governor should continue to seek ways in which the results of increasingly demanding tests in mathematics can be translated more directly into school improvement and the provision of individual remediation.
- The Missouri General Assembly should adopt legislation explicitly identifying the state's interest in raising mathematics achievement levels. Such legislation should establish a grant program

through the State Board of Education to help integrate algebraic thinking into elementary, middle, and junior high school classes.

Advice for Sponsoring Boards

- The sponsoring boards should review current data systems with the goal of having common data definitions that allow for the identification of research initiatives. In addition, board-sponsored statewide research activities across all educational levels should strive to provide policymakers with useful data about student performance and the preparation of teachers.
- A permanent mathematics technical advisory committee of faculty should be appointed to ensure faculty perspective and support in the development of new public policy initiatives.
- Incentives should be identified and used to support improvements in teaching and learning throughout Missouri's educational system, collaboration across educational sectors, and curricular changes that will provide better coherence and continuity for students.
- The State Board of Education should work with the Coordinating Board for Higher Education in defining a collaborative role for the Coordinating Board to play in the review of existing teacher education programs.
- By showcasing best practices, the sponsoring boards can reinforce networking and coordination while promoting innovation and the cross-fertilization of ideas.

Looking to the Future

As the Missouri K-16 Coalition looks ahead, it seems clear that, whatever its next focus, two tasks must be on the agenda:

- monitoring the implementation of its recommendations on mathematics and the results therefrom; and
- enlisting the participation of all groups at the local, state, and national levels that share a commitment to improving student performance, such as local public school education foundations and parent, business, and community support groups in specific school districts; the Partnership for Outstanding Schools in Missouri; and the Learning First Alliance, a national coalition of 12 national education associations in Washington, D.C. representing 10 million members.

APPENDIX I

Charge to the Missouri K-16 Coalition

The Coordinating Board for Higher Education, the State Board of Education, and the University of Missouri Board of Curators have formed a historic new partnership in support of high quality standards for all students in their pursuit of knowledge. Prominent Missourians committed to quality education at all levels have been appointed to the Missouri K-16 Coalition. Coalition members will work together in an effort to create a seamless education system and to raise expectations and performance levels of all students, from kindergarten through the baccalaureate degree. The Coalition will work with all sectors of elementary, secondary, and higher education, both public and private.

The Coalition is initially being asked to concentrate on the important area of mathematics and to consider ways in which the success of Missouri students in mathematics can be increased. The focus will be on grades 11 and 12 and the first two years of higher education. The Coalition is charged with:

- Promoting quality performance standards that reduce the need for remediation
- Encouraging faculty agreements on content and expectations in the major disciplines, beginning with mathematics
- Increasing public awareness of the importance of improved student performance
- Supporting full articulation within and across educational sectors
- Identifying strategies for enhanced student performance based upon preparation and ability
- Developing policy recommendations to be shared with the Coordinating Board for Higher Education, the State Board of Education, and the UM Board of Curators

Dr. Melvin D. George, President Emeritus of the University of Missouri and principal author of the National Science Foundation's report *Shaping the Future*, will chair the Coalition. Additional projects beyond mathematics will be considered throughout the year. Educators and business and government leaders are joining together to make a difference for Missouri's youth as they prepare for a future that will be filled with challenge and change.

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APPENDIX II

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APPENDIX III

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